ARIES SYSTEM 300 Music Synthesizer
ARIES MODULE 313
AR-313 KEYBOARD INTERFACE ASSEMBLY INSTRUCTIONS

The General Assembly Instructions were written as a general guide, to familiarize the builder with the components. Here, now, are the specific assembly instructions for building your Keyboard Interface.It is recommended that you do the following before you proceed:

Find a place where you can work through completion,, without disturbing your set-up.

Use adequate lighting.

Wash your hands before starting.This removes contaminating oils and perspiration, and makes assembly more comfortable.

As you proceed, check off each step with a pencil.

IMPORTANT! THE AR-313 INTERFACE CONSISTS OF TWO PRINTED CIRCUIT BOARDS ("A" AND "B") AND ONE FRONT PANEL CONTROL UNIT. IT IS DESIGNED TO WORK WITH THE AR-311 KEYBOARD, AND MOUNT IN THE AR-300 KEYBOARD CASE.

I. Board "A" Assembly

( ) 1. PREPARATION Lay the circuit board on a sheet of white paper. PLACE METAL FOIL SIDE DOWN! Also, turn board so that connector strip is to the LEFT. Use adequate lighting.

Lay the assembly drawing(layout) down near the board.

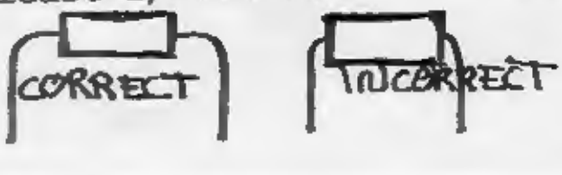
Unpack the parts carefully and place in a large box or tray so they won't get lost.

Have the following tools nearby;
- Pencil tip soldering iron, hot and tinned(solder-coated)
- Solder-Use only thin,rosin-core solder !
- Small,diagonal wire cutters
- Small wire stripper
- Small long-nose pliers

( ) 2. JUMPERS Find jumper wire J1 on the drawing. Cut off a piece of insulated, solid wire, ONE INCH LONGER THAN J1. Strip 1/2 inch of insulation from each end (being careful not to damage the wire itself). Bend the bare ends to a right angle and insert into the holes on the board, according to the drawing. While holding the ends down against the board, bend them at a 45 degree angle on the foil side of the board, to hold the wire in place. Solder and cut off the excess.(Refer to introduction on parts installation.)

Install J2 through J5 in the same way.

( ) 3. RESISTORS Carefully install all 47 resistors (R122 through R168) on the circuit board. To avoid breaking the resistor leads, bend the leads at least 1/16th of an inch away from the body of the resistor.
For example:



NOTE: a) Resistors R1 through R60 are on the keyboard.
b) Resistors R61 through R121 are on board "B"
c) Resistor R154 mounts with one lead bent underneath, as shown on the layout.
d) NOTE: R168 must be mounted as shown, with a piece of insulated wire soldered to one end.

( ) 4. CAPACITORS Install all 24 capacitors (C62 through C85). observe polarity where shown.NOTE: C79 is actually much larger that shown on the drawing. Bend the leads like this.

Install, being careful not to let its leads touch any other wires.

( ) 5. DIODES Install all 8 diodes(D62 through D70), observing polarity. (There is no D64).

( ) 6. INTEGRATED CIRCUITS Install all 12 I C's (U1 through U12). OBSERVE ORIENTATION!

( ) 7. TRANSISTORS Install all 5 transistors (Q1 through Q5).

THIS COMPLETES ASSEMBLY OF BOARD "A"

II NOW, WIRE BOARD "B"
( ) 1. Install all 61 resistors(R61 through R121).

( ) 2. Install all 61 capacitors (C1 through C61).

( ) 3. Install all 61 diodes (D1 through D61). NOTE: Observe polarity on capacitors and diodes.Don't forget R121, C61, and D61 on the right-hand edge!

THIS COMPLETES ASSEMBLY OF BOARD "B".

III PANEL WIRING
PLEASE REFER TO PANEL WIRING DIAGRAM.

( ) 1. Mount the 14 mini-phone jacks in THE EXACT POSITION SHOWN.Tighten all nuts.

( ) 2. Mount the two switches (S1 and S2) as shown.

( ) 3. Mount all four pots (P1,P2,P3,P4) as shown.NOTE: Although all four pots are of the locking-nut, screwdriver adjust type, only P1 and P2 will need the locking nut on. P3 and P4 will only be used with knobs.

( ) 4. Mount knobs on P3 and P4.

( ) 5. Solder a wire to the grounds of the four jacks on the left side (rear view) as shown.

( ) 6. Connect the two upper jacks together as shown.

( ) 7. Connect all four jacks in the next row down.

( ) 8. Repeat for the 3rd row.

( ) 9. Repeat for the bottom row.

( )10. Connect pins 1 and 2 of P2 together.

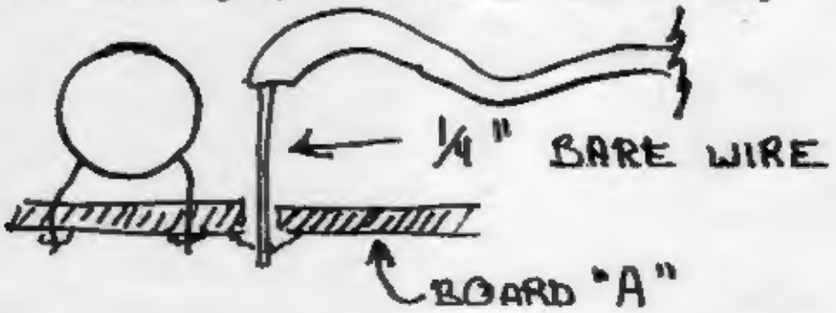
( )11. Connect pin2 of S2 to Pin one of P3.

( )12. Connect pin3 of S1 to pin 2 of P3

IV NOW PROCEED TO WIRE THE PANEL TO BOARD "A".

( ) 1. Cut off 19 pieces of insulated wire, each 11 inches long. Strip 1/2" off each end.

( ) 2. Connect the wires from each point on the panel (shown by the arrow) to the corresponding point on Board "A".TO AVOID MISTAKES, CONNECT BOTH ENDS OF EACH WIRE BEFORE GOING TO THE NEXT WIRE.NOTE:When wiring the ground connection to Board "A", strip an extra 1/2" of insulation (one inch total) from the wire end. Push this wire through the board hole leaving 1/4" of BARE wire on top.
SOLDER:



This is to allow two additional wires to connect here.

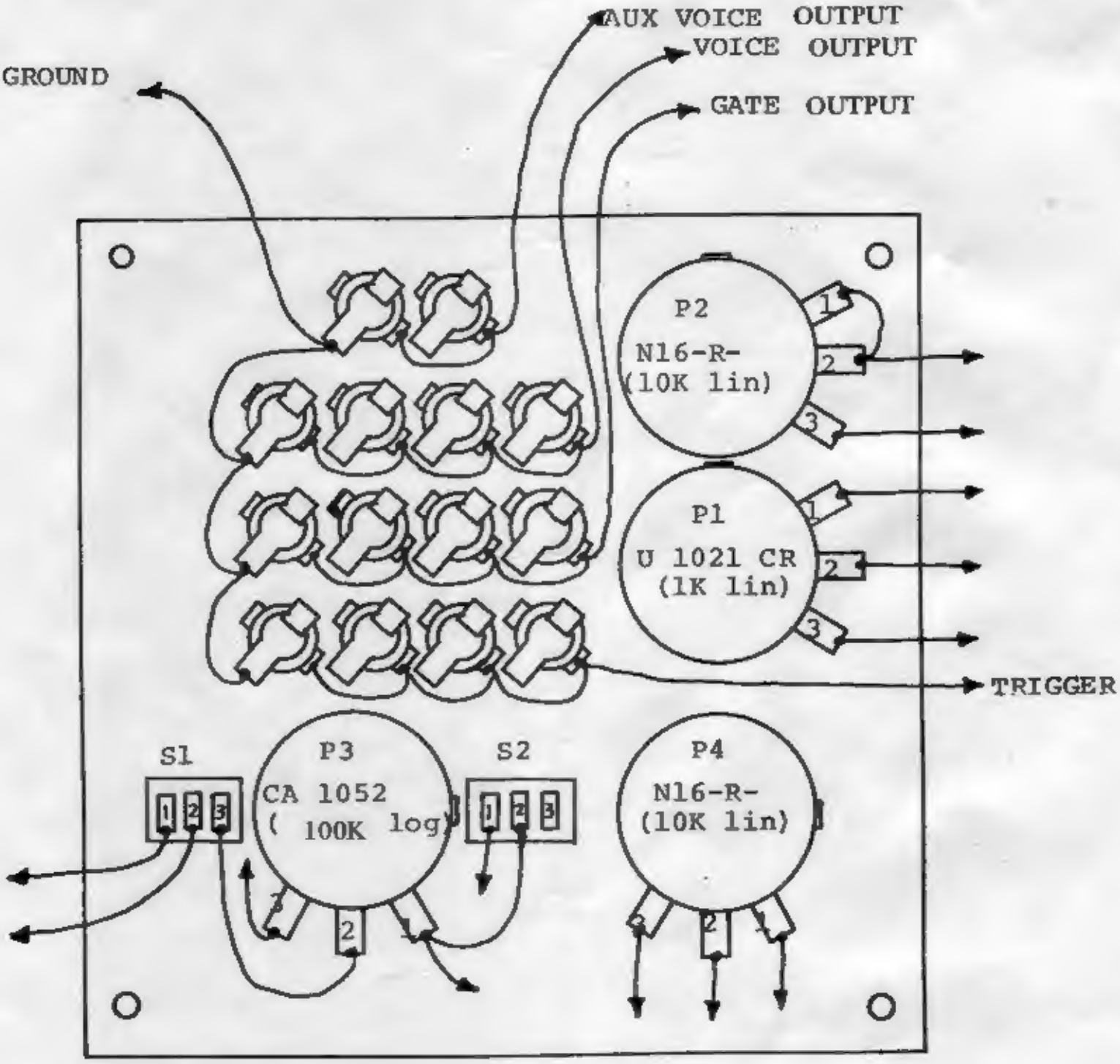
V NOW WIRE BOARD "A" AND BOARD "B" TOGETHER FOR THE POWER SUPPLY.

( ) 1. Cut a piece of insulated wire 45" long.Strip 1/2" of insulation from each end. Wrap one end around the bare ground wire on Board "A" (from previous step). Solder . Solder the other end in the hole on Board "B" labelled "GROUND" on the drawing.

( ) 2. Cut another 45" piece of insulated wire. Strip one inch of insulation off one end. Push through hole in Board "A" labelled "+15v supply" on drawing, leaving 1/4" bare wire on top, as you did on the ground wire.Solder. Solder the other end to the hole in board "B" labelled "+15 volts".

THIS COMPLETES ASSEMBLY OF YOUR AR-313 KEYBOARD INTERFACE.

ARROW INDICATES A WIRE TO BOARD "A"



AR-313 KEYBOARD INTERFACE

PANEL WIRING-REAR VIEW

THEORY OF OPERATION OF AR-313 * * * KEYBOARD INTERFACE
(WITH AR-311 KEYBOARD)

The AR-311 keyboard has a string of 60 precision 10 ohm resistors in series, forming a voltage divider. One end is grounded, the other end fed by a constant-current source, consisting of Q1 and R124, biased by R122, R123, D62, and adjusted by P1. One set of key contacts connects a different tap on the voltage divider to the bus called "KBD,VOICE". The lowest key connects to the grounded end, and the highest key to the other end, of the divider. When one key is depressed, the "VOICE" bus will have a voltage proportional to the number of keys up from ground. The current source is adjusted for 1/12 volt per key, or 1 volt per octave. When two or more keys are depressed simultaneously, the "VOICE" bus voltage depends only on the position of the LOWEST key, since the current through the resistors between the lowest key and ground is constant. However, the voltage at the top of the divider (connection called "KBD HIGH") will drop by 1 volt for each octave interval between the lowest and highest keys depressed simultaneously. When only one key is depressed there is no change in this voltage from no keys depressed. This voltage will be 5 volts (1 volt per octave times five octaves).

In addition, there is a second set of contacts, called "Keyboard Gate Switches". Each note has a capacitor (C1 thru C61), resistor (R61 thru R121) and diode (D1 thru D61). The capacitors are normally charged to +15 volts. When a note is depressed, the capacitor discharges partially through the diode into the resistors R132 and R133, causing the voltage at the output bus to momentarily reach about +14 v. The capacitor will discharge until the 1M resistor supplies enough current to equal that lost through R132, at which time the bus voltage will be 2.4 volts. It will remain at this voltage as long as the key is held down.

Now, when any one key is depressed, there are 4 signal paths affected:
A. The voltage at pin 3 of op amp U3 will reach 7 volts, then remain at 1.2 volts, due to the divider R132 and 133. (C66 filters out any contact bounce noise.) U3 acts as a comparator, since it is open-loop. The voltage on pin 2 is biased by R134 and R135 to +0.7 volts. Therefore, the output will normally be -15 volts, but will jump to +12 volts (saturation voltages of U3) when a key is depressed. This turns on FET switch Q2, which charges up holding capacitor C64 to the voltage on the "KBD. VOICE" bus, which is buffered by voltage follower U9. This same positive output from U3 is inverted by U4A (1/4 of a quad 2- input NOR gate), which goes to logic "0" level (near 0v). U4B will have a similar "low"output unless <u>both</u> inputs (pins 12 and 13) are low.

B. Capacitor C75 couples a momentary pulse (0.8ms) of about +14 volts into Darlington emitter follower Q4, which couples the pulse into pin 3 of U6. U6 is a"one shot" whose output (pin 8) first goes "high" (near +5 volts) when turned on by the pulse at pin 3. After a delay of 7ms (determined by C69), the output goes"low" again. Meanwhile, when the output first goes high, U4B now has one input low and one high, so its output stays low. Therefore, the output of op-amp comparator U5 stays low (-15 volts.) This keeps pin 1 of U6 low, which enables Pin 3 input to work.

However, after the delay of 7 ms, pin 8 of U6 goes low again. Assuming the key is still down, this means both inputs of U4B are low, so its output (pin 11) goes high.This turns on U5 (+12 volts) which causes a gate (+10 v) to appear at the GATE OUTPUT. Notice that the gate is delayed, to give the sample hold (Q2 and C64) a chance to acquire the correct keyboard voice (control voltage) before the gate turns on.

C. The third signal path is through U4C, which inverts the 0.8ms pulse through C75. The resulting negative pulse (actually from +5v to around **0V**) is coupled through emitter follower Q5 to pin 2 of U7.

Now, before depressing the key, pins 3 and 1 of U7 were low, and pin 2 was high. When the key is depressed, the rising gate at U5 output turns on the output of U7 (pin 8) for a time of 1.6ms, determined by C71, after which it goes low again. This pulse is amplified by op amp comparator U8 to produce an output trigger pulse of +10 volts and 1.6ms duration, simultaneous with the start of the gate output. 10 microseconds after the start of the gate and trigger, however, C70 charges enough to turn on pin 1 of U7. This inhibits the input at pin 3 from keeping the output of U7 on.

Incidentally, the connection of U5's output to pin 1 of U6 prevents additional pulses due to the depression of more than one key from turning on U6, which would cause a momentary "notch" in the gate output

Now back to U7. Although the positive input at pin 1 inhibits pin 3 from holding U7 high, pin 2 is still free to act. When one or more keys are held down, any additional key will still generate a pulse through C75. The resulting negative pulse at pin 2 of U7 will cause it to generate a trigger pulse.

D. The fourth signal path in from the "KBD VOICE" bus.As already mentioned, Q2 turns on as aoon as a key is depressed, charging C64 to the right control voltage. When the key is released, Q2 is open, and the high impedance follower consisting of Q3 and U10 buffers the voltage on C64, without discharging it. This circuit, then "remembers" the keyboard bus voltage.

Now, U10 and follower U11 comprise a feedback circuit to give two types of variable lag (Portamento) to changes in the input.

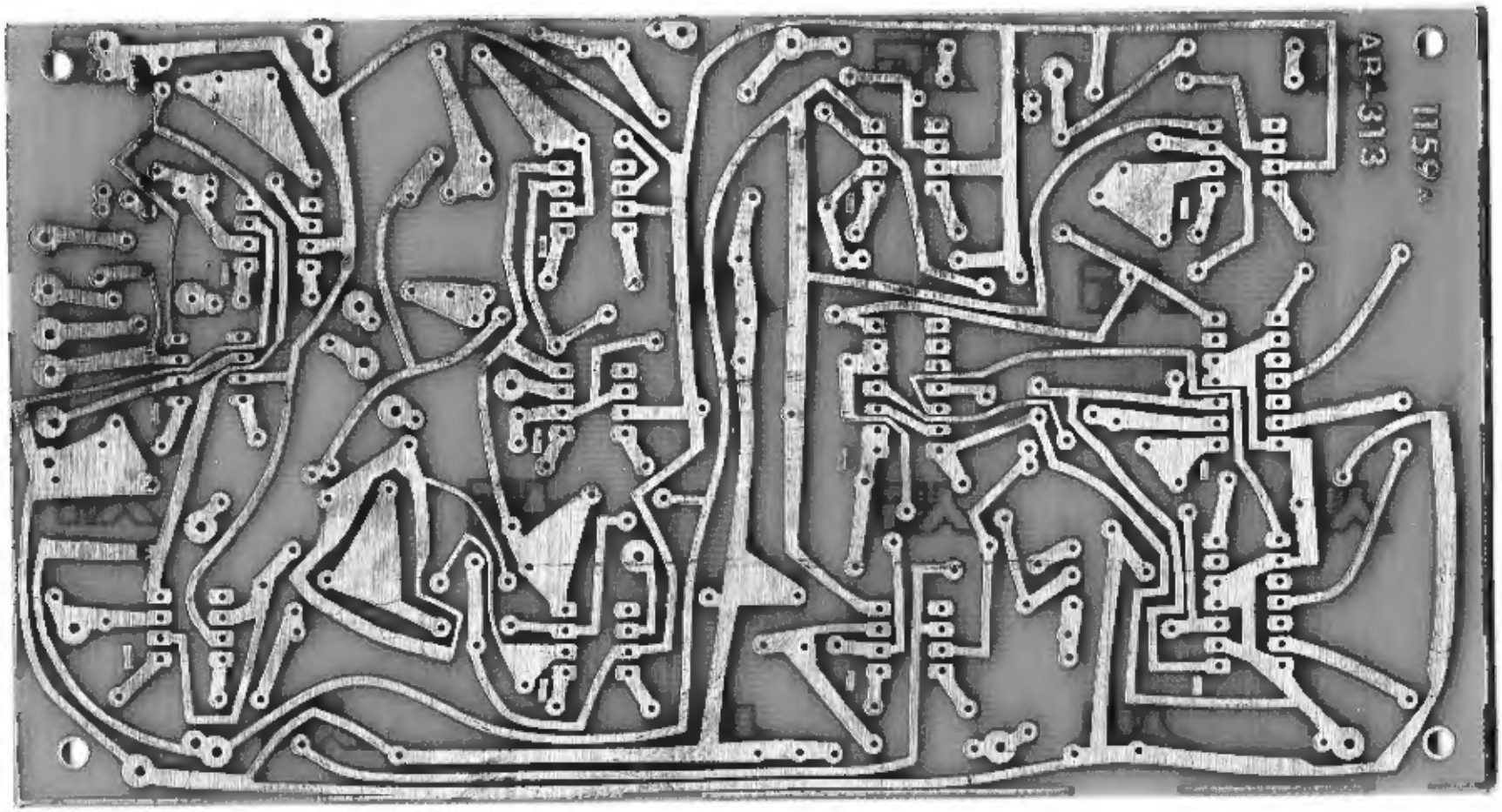
With S2 in the linear mode,a positive change in voltage across C64 will immediately cause U10's output to go fully positive, since it is open loop. Then, C79 will charge through the counter-clockwise section of P3, the Portamento part.It will charge exponentially toward about 12 volts, but as it nears the new input voltage, feedback from U11 will, after a time, neutralize the input of U10.Since the total change of voltage across C79 is small compared to the initial charging voltage of 12v, the rate of change in output voltage is nearly linear.

On the other hand, putting S2 in the "normal" position adds negative feedback around U10, preventing it from saturating. This causes C79 to charge exponentially, except for large keyboard intervals, when some saturation does occur at first. Thus, the "normal" position is a compromise between exponential and linear portamento.

The output of U11 is coupled into U12, which is a differential amplifier. U11's output appears at U12's output noninverted , with unity gain. Thus, the VOICE OUTPUTS are 1 volt per octave.

The tuning pot, P4, provides a variable voltage from +15v to -15v.(0 volts in the center). However, there is a range near the center where the voltage, after being divided by R165 and R166, is less than the forward drop of D69 and D70, so virtually no voltage appears across R164 and R163. When this range is exceeded, however, the resulting positive or negative voltage gets inverted and summed into the VOICE output, detuning the note flat or sharp, respectively. The "dead space" in the middle of P4's rotation provides a quick return to original tuning (for example, concert pitch, where A=440 Hz.)

There is one additional signal patch when more than one key is depressed simultaneously. This lowers the"KBD High" voltage from its normal 5 volts value. The voltage is buffered by U1, and inverted by U2, R154 compensat for the normal 5 volt level so the AUX VOICE output is normally near 0 volts. The AUX VOICE INTERVAL trim, P2, adjusts the gain for 1 volt change in the AUX VOICE output, per one octave interval between the lowest and highest keys depressed.When summed with the regular VOICE output, by plugging both into the same VCO, the VCO will respond to the highest note played. Together with another VCO only connected to a VOICE output, two notes can be played together.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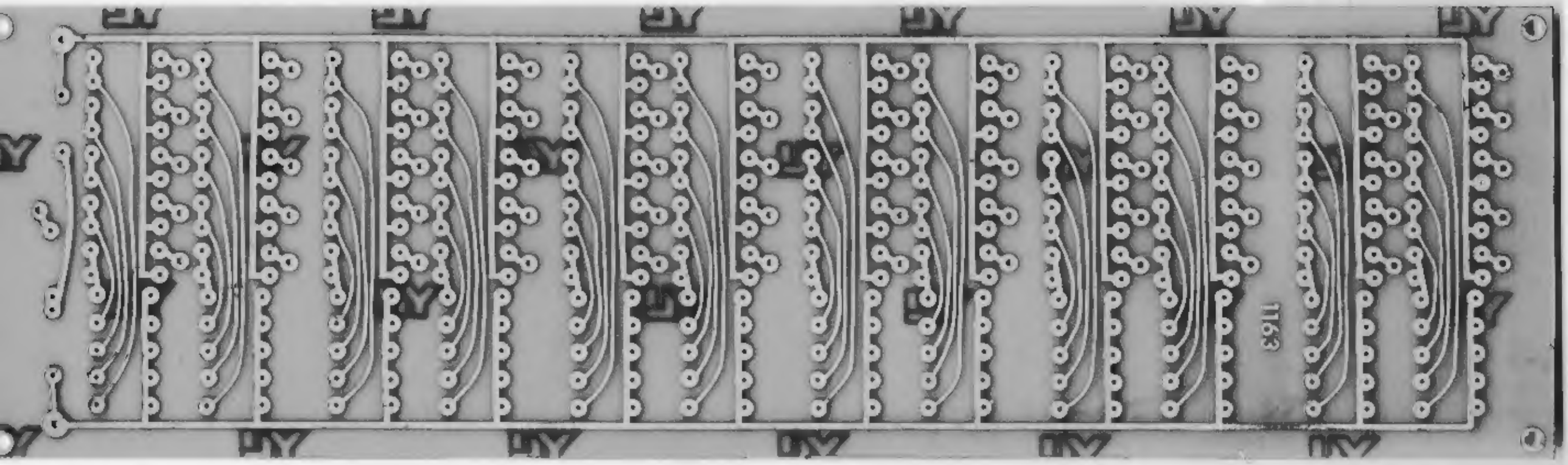
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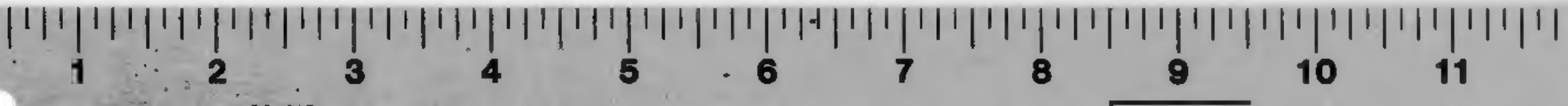
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2
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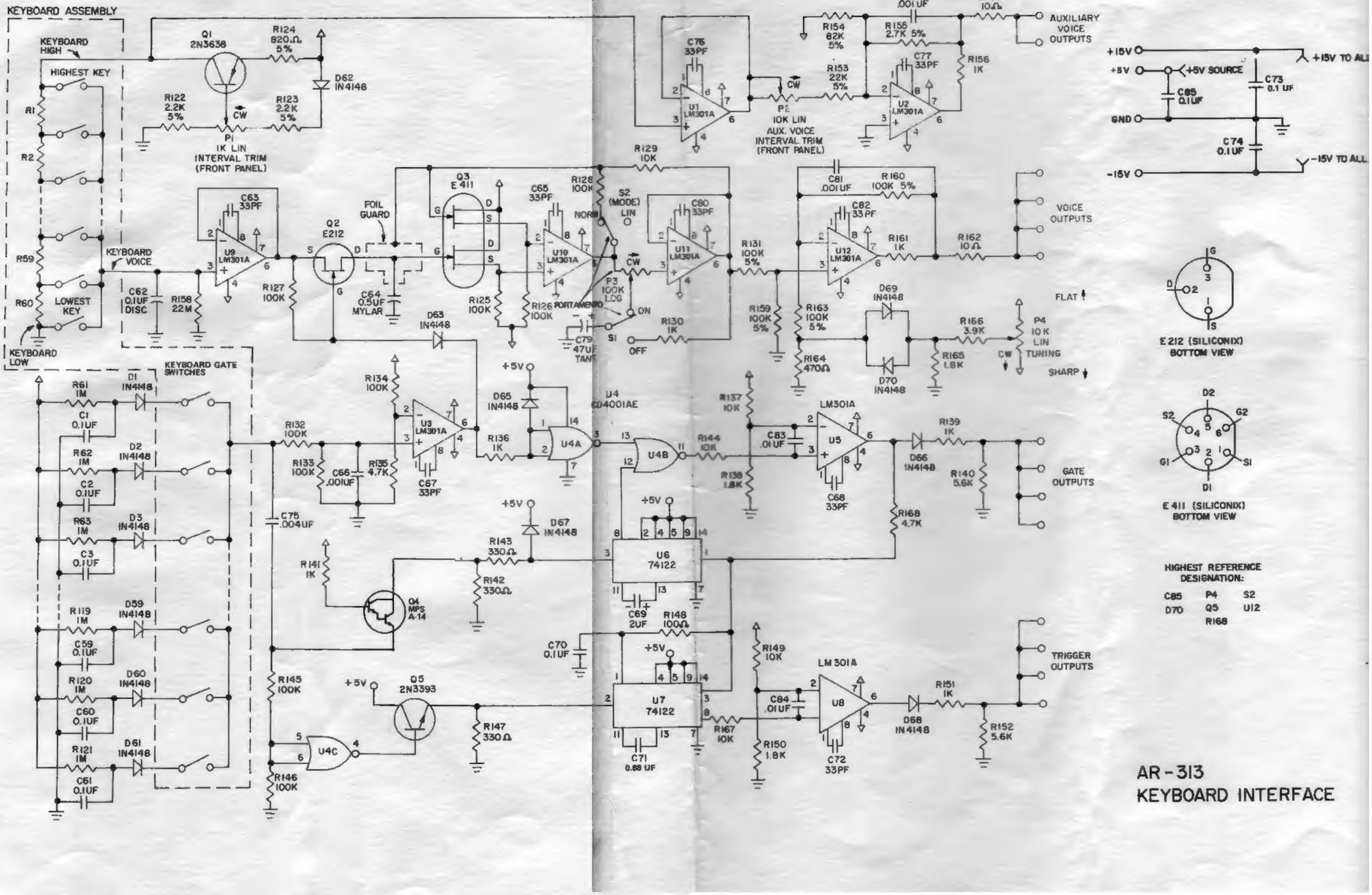
10
11

PARTS LIST AR-313 * KEYBOARD INTERFACE

PART NUMBERS	QUANTITY	DESCRIPTION	VALUE AND RATINGS
C1 thru C61	61	Capacitor,Electrolytic	0.1 mfd,25v
C62,~~70~~,~~73~~,~~74~~,~~85~~ C63,65,~~67~~,~~68~~,~~72~~	5	" Disc	0.1mfd,50v
~~76~~,~~77~~,80,~~82~~	9	" "	33 pf
~~C64~~	1	Capacitor-Mylar,Mica,or Poly.	0.47mfd, 100v, 10%
C69	1	Capacitor,Tantalum	2.2 mfd,20v
~~C71~~	1	Capacitor, Ceramic	0.68 mfd
~~C75~~	1	Capacitor,Disc	0.004 mfd
C66,~~78~~,~~81~~	3	" "	0.001 mfd
~~C83~~,~~84~~	2	" "	0.01 mfd
D1 thru 70 (D64 deleted)	69	Diode,Silicon	1N914,1N4148
D71	*1*	*Diode, Zener*	*10v - 1 watt*
P1	1	Potentiometer,1/4" Slotted Shaft	1k linear
P2	1	" "	10k linear
P3	1	Potentiometer,1/4" shaft	100k log
P4	1	" "	10k linear
~~Q1~~	1	Transistor,PNP	2N3638
~~Q2~~	1	Field Effect Transistor n-channel	E212(Siliconix)
~~Q3~~	1	Field Effect Transistor, dual n-channel	E411(Siliconix)
Q4	1	Transistor,NPN, Darlington pair	MPS A-14
Q5	1	Transistor,NPN	2N3393 or TE-3393
~~C79~~	1	Capacitor,Tantalum	47 mfd,20v
R1 thru 60	60	Resistor,Metal Film	10 ohm,1% (part of kbrd assembly)
R61 thru 121	61	Resistor,Carbon	1 meg, 10%
R122,~~123~~	2	Resistor,Carbon Film	2.2k, 5%
R ~~124~~	1	" " "	820 ohm,5%
R~~125~~,~~126~~,~~127~~,~~128~~,~~132~~,~~133~~	6	Resistor,Carbon	100k, 10%
R~~134~~,~~145~~,~~146~~	3	" "	100k, 10%
R~~129~~,~~137~~,~~144~~,~~149~~,~~167~~	5	" "	10k,10%
R~~130~~,~~136~~,~~139~~,~~141~~,~~151~~,~~156~~,~~161~~	7	" "	1k, 10%
R~~131~~,~~159~~,~~160~~,~~163~~	4	Resistor,Carbon Film	100k, 5%
R~~135~~,~~168~~	2	Resistor,Carbon	4.7k. 10%
R~~138~~,~~150~~,~~165~~	3	" "	1.8k,10%
R~~140~~,~~152~~	2	" "	5.6k. 10%
R~~142~~,~~143~~,~~147~~	3	" "	330 ohm,10%

PARTS LIST * AR-313 * (cont.)

PART NUMBER	QUANTITY	DESCRIPTION	VALUE AND RATINGS
R148	1	Resistor,Carbon	100ohm, 10%
R153	1	Resistor,Carbon Film	22k,5%
R154	1	" " "	82k,5%
R155	1	" " "	27k,5%
R157,162	2	Resistor,Carbon	10 ohm,10%
R158	1	" "	22 meg,10%
R164	1	Resistor,Carbon	470 ohm,10%
R166	1	" "	3.9k.10%
S1,2	2	Switch,Toggle	SPDT
U1,2,3,5,8,9,10,11,12	9	Operational Amplifier	LM301A
U4	1	Quad Dual Input Nor Gate	CD4001AE
U6,7	2	Monostable Multivibrator	74122
	1	Front Panel	
	2	Knobs,1/4" shaft	
	14	Jacks,Mini-Phone	
	2	Printed Circuit Board	
	4	4-40 Nut	
	4	4-40x5/16" Screw	
	4	1/8" Fiber Spacer	
	4	Flat Bracket	
	12	#4x1/2" Wood Screw	



AR-313
KEYBOARD INTERFACE

KEYBOARD ASSEMBLY
KEYBOARD HIGH
HIGHEST KEY
R1
R2
R59
R60
LOWEST KEY
KEYBOARD LOW
KEYBOARD VOICE
KEYBOARD GATE SWITCHES
D1 IN4148
R61 1M
C1 0.1UF
D2 IN4148
R62 1M
C2 0.1UF
D3 IN4148
R63 1M
C3 0.1UF
D59 IN4148
R119 1M
C59 0.1UF
D60 IN4148
R120 1M
C60 0.1UF
D61 IN4148
R121 1M
C61 0.1UF
Q1 2N3638
R124 820Ω 5%
D62 IN4148
R122 2.2K 5%
R123 2.2K 5%
P1 1K LIN INTERVAL TRIM (FRONT PANEL)
C62 0.1UF DISC
R158 22M
C63 33PF
U9 LM301A
R127 100K
Q2 E212
FOIL GUARD
C64 0.5UF MYLAR
D63 IN4148
Q3 E411
R129 10K
R128 100K
S2 (MODE) LIN NORM
C65 33PF
U10 LM301A
R125 100K
R126 100K
PORTAMENTO
P3 100K LOG
C79 47UF TANT
S1 ON OFF
R130 1K
C80 33PF
U11 LM301A
C75 33PF
U1 LM301A
P2 10K LIN AUX. VOICE INTERVAL TRIM (FRONT PANEL)
R153 22K 5%
C78 .001UF
R154 82K 5%
R155 2.7K 5%
C77 33PF
U2 LM301A
R157 10Ω
R156 1K
AUXILIARY VOICE OUTPUTS
+15V TO ALL
+15V
+5V
+5V SOURCE
C85 0.1UF
GND
C73 0.1 UF
C74 0.1UF
-15V
-15V TO ALL
C81 .001UF
R160 100K 5%
C82 33PF
U12 LM301A
R161 1K
R162 10Ω
VOICE OUTPUTS
R131 100K 5%
R159 100K 5%
R163 100K 5%
R164 470Ω
D69 IN4148
D70 IN4148
R166 3.9K
R165 1.8K
P4 10K LIN TUNING
FLAT
SHARP
E212 (SILICONIX) BOTTOM VIEW
R134 100K
U3 LM301A
R132 100K
R133 100K
C66 .001UF
R135 4.7K
C67 33PF
+5V
D65 IN4148
U4 ED4001AE
U4A
R136 1K
U4B
R137 10K
R138 1.8K
R144 10K
C83 .01UF
U5 LM301A
C68 33PF
D66 IN4148
R139 1K
R140 5.6K
GATE OUTPUTS
R168 4.7K
D67 IN4148
R143 330Ω
R141 1K
R142 330Ω
Q4 MPS A-14
U6 74122
C69 2UF
R148 100Ω
C70 0.1UF
R145 100K
Q5 2N3393
R147 330Ω
U4C
R146 100K
U7 74122
C71 0.68 UF
R149 10K
R150 1.8K
R167 10K
C84 .01UF
U8 LM301A
C72 33PF
D68 IN4148
R151 1K
R152 5.6K
TRIGGER OUTPUTS
E411 (SILICONIX) BOTTOM VIEW
HIGHEST REFERENCE DESIGNATION:
C85 P4 S2
D70 Q5 U12
R168
AR-313
KEYBOARD INTERFACE

AR-313 KEYBOARD INTERFACE

TRIM PROCEDURE (WITH ARIES SYNTHESIZER)

VOICE TRIM

1. Connect the keyboard power cable to the synthesizer.Turn on.
2. Connect a patch cord from one voice output just to control #2 on one VCO.
3. Set keyboard tuning to center, and portamento off.
4. Mix the sawtooth outputs of this VCO and another one, with NO control inputs, and listen to them. Set both dials to 250 Hz.
5. While holding down the lowest key (c),carefully tune either VCO for zero beat, that is, the same frequency.
6. Loosen locking nut on VOICE INTERVAL trim pot on keyboard panel (if used).
7. Release the lowest key, and hold down the "C" key two octaves up (the 15th white key).
8. Adjust the VOICE INTERVAL trim so that the VCO's are exactly two octaves apart.
9. Repeat steps 5, 7, and 8 until the VCO's are in unison at the lowest key, and two octaves apart at the 15th white key, without needing further trimming.
10. Tighten the lock nut and check the VCO's again.

AUXILIARY VOICE TRIM

1. Now connect a patch cord from the VOICE output to control input #2 of the second VCO. (Leave the first one connected also).
2. While holding the lowest key down, tune the VCO's exactly in unison.
3. Play different notes, and check that the VCO's stay in unison closely. If not, one of them needs adjustment of its "VOLTS PER OCTAVE " trim.
4. Connect a patch cord from one AUX. VOICE output jack to control input #3 of one VCO.
5. Hold the lowest note down, and tune the VCO's exactly in unison.
6. Loosen the locking nut (if used) on the AUX. VOICE INTERVAL trim pot.
7. Simultaneously hold down the lowest key and the one an octave higher (the 8th white key).
8. Adjust the AUX. VOICE INTERVAL trim so the VCO's are exactly one octave apart.
9. Repeat steps 5, 7, and 8 until the VCO's are in unison with only one key down, and one octave apart with two keys an octave apart held down.

NOTE: THIS TRIM MAY BE DIFFICULT BECAUSE IT ALSO AFFECTS THE TUNING. IF YOU HAVE TROUBLE, THE FOLLOWING WILL HELP.

ADDITIONAL TRIM INSTRUCTION

1. Listen only to the VCO which has the AUX. VOICE connection plus the VOICE connection.
2. Hold down the lowest key, and alternately push and release the next octave (8th white key).
3. Adjust the AUX. VOICE INTERVAL trim so that you hear an octave change when you play and release the octave key.When adjusted, tighten the locking nut and check the intervals again.